IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re Patent Application of

BEAN et al. Atty. Ref.: 3638-115 (AMK)

Serial No. 10/786,164 TC/A.U.: 3634

Filed: February 26, 2004 Examiner: A. Chin Shue

For: BOOM LIFT VEHICLE AND METHOD OF CONTROLLING LIFTING FUNCTIONS

* *

January 8, 2008

Mail Stop Appeal Brief - Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

APPEAL BRIEF

Sir:

Appellants hereby **appeal** to the Board of Patent Appeals and Interferences from the last decision of the Examiner.

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(I) REAL PARTY IN INTEREST

The real party in interest is JLG Industries, Inc., a corporation of Pennsylvania.

(II) RELATED APPEALS AND INTERFERENCES

The Appellants, the undersigned, and the assignee are not aware of any related appeals, interferences, or judicial proceedings (past or present), which will directly affect or be directly affected by or have a bearing on the Board's decision in this Appeal.

(III) STATUS OF CLAIMS

Claims 1-22 are present in this application. Claims 1-22 have been rejected. No claims have been substantively allowed.

(IV) STATUS OF AMENDMENTS

No amendments have been filed since the date of the Final Rejection.

(V) SUMMARY OF CLAIMED SUBJECT MATTER

The invention relates to boom lift vehicles and, more particularly, to a boom lift vehicle including a tower boom pivotally coupled with a main boom and a method of controlling lifting functions of the boom lift vehicle. With reference to Fig. 1, a boom lift vehicle 10 includes a vehicle base 12 supported by a plurality of wheels 14. A counterweight 16 is fixed to the vehicle base 12 to counterbalance turning moments generated by the vehicle boom components. The vehicle base 12 also houses suitable drive components coupled with the vehicle wheels 14 for driving the vehicle. See page 5, lines 22-26.

A telescoping tower boom 18 is pivotally coupled at one end to the vehicle base 12. A lifting member 20 such as a hydraulic cylinder is disposed between the tower boom 18 and the vehicle base 12 for effecting tower lift functions. The tower boom 18 includes telescope sections that are coupled with suitable driving means (not shown) to effect telescope extend/retract functions. A nose pin 22 of the tower boom is disposed at an uppermost end of the tower boom 18 opposite the end pivotally attached to the vehicle base 12. See page 6, lines 1-7.

A main boom 24 is pivotally coupled to the tower boom 18 at the tower boom nose pin 22. A suitable lifting mechanism 26 such as a hydraulic cylinder drives a position of the main boom 24 relative to the tower boom 18. See page 6, lines 8-12. In contrast with conventional articulating boom lift vehicles, the tower boom 18 and the main boom 24 are preferably without a conventional upright between them. Instead, the

boom lift vehicle 10 of the invention utilizes sensing structure for sensing an angle of the main boom, preferably relative to gravity. For example, an inclinometer 30 may be attached to the tower boom 18 for measuring an angle of the tower boom 18 relative to gravity. A rotation sensor 32 is coupled between the tower boom 18 and the main boom 24 for determining a relative position of the tower boom 18 and the main boom 24. A control system 34 controls lift and telescope functions of the tower boom 18 and the main boom 24. See page 6, lines 15-28.

The control system 34 controls tower lift and telescope functions in order to control a path of the tower nose pin 22 through a predetermined path. A tower length sensor communicates with the control system 34 to determine a telescope length of the tower boom 18. A single control switch shown schematically at 36 in Fig. 1 effects raising and lowering of the tower boom, and the control system 34 automatically controls tower lift and telescope functions to follow the predetermined path depending on the main boom angle. See page 6, line 29 – page 7, line 6.

Fig. 2 illustrates the nominal tower boom path controlled via the control system 34. The tower path is a fixed relationship of tower length and tower angle (preferably relative to gravity) and is variable only by the angle of the main boom 24. Fig. 3 schematically illustrates differences in the tower path with different main boom angles. See page 7, lines 7-15.

Movement of the main boom 24 will cause the control system 34 to adjust the tower path accordingly. See page 7, lines 16-21.

The control system 34 controls the path 38 of the tower nose pin 22 by simultaneously controlling pivoting of the tower boom 18 relative to the vehicle base 12 and telescoping of the tower boom 18. In this manner, the controlled nominal tower boom path shown in Fig. 2 can be effected, whereby the tower boom 18 can be raised to its max position considerably faster than with conventional arrangements. Pivoting of the tower boom 18 relative to the vehicle base 12 and telescoping of the tower boom 18 are controlled such that the nose pin 22 predetermined path follows (1) a constant radius equal to a fully retracted length of the tower boom 18 for tower boom angles (+/-) less than a predetermined angle determined relative to gravity, and (2) a substantially straight line tangent to the constant radius for tower boom angles greater than the predetermined angle. See page 7, line 22 – page 8, line 11.

An angle of the main boom 24 relative to the tower boom 18 is controlled by maintaining the main boom angle, preferably relative to gravity, as measured at (1) the commencement of a tower lift control, or (2) a conclusion of a main boom lift command when the main boom 24 is active with a tower lift command. When tower lift down is commanded, the control system 34 maintains the main boom angle according to the noted parameters unless the minimum angle with respect to the tower 18 has been reached, at which point the minimum angle with respect to the tower boom 18 is maintained. See page 8, lines 22-28.

Fig. 4 is a flow chart showing the method of the invention.

The control system 34 controls the main boom 24 when the tower boom 18 is below the tower boom elevation angle to maintain a main boom angle relative to gravity at a first set point angle. The first set point angle is determined as the main boom angle (1) at a start of the swing function or vehicle drive, or (2) at a conclusion of the main lift function when combined with at least one of the swing function or vehicle drive. When the tower boom 18 is above the tower boom elevation angle, the control system 34 controls the tower boom 18 to maintain a tower boom angle relative to gravity at a second set point angle. The second set point angle is determined as the tower boom angle (1) at a start of the main lift function, the main telescope function, the swing function or vehicle drive, or (2) at a conclusion of the tower lift function when combined with at least one of the main lift function, the main telescope function, the swing function or vehicle drive. See page 9, line 23 – page 10, line 4.

SPECIFIC SUPPORT FOR INDEPENDENT CLAIMS

1. A method of controlling a tower boom path in a boom lift vehicle, the boom lift vehicle including a telescoping tower boom pivotally coupled at one end to a vehicle base, and a main boom pivotally coupled to a tower boom nose pin at an opposite end of the tower boom **[see page 6, lines 1-12]**, the method comprising raising and lowering the tower boom between a fully retracted position and a raised position by pivoting the tower boom relative to the vehicle base and by telescoping the tower boom, the raised position including any position up to a maximum angle of the tower boom relative to the vehicle base and a maximum boom length **[see page 7, lines 7-15]**, wherein pivoting of the tower

boom relative to the vehicle base and telescoping of the tower boom are performed simultaneously and independently such that the tower boom nose pin follows one of a plurality of predetermined paths depending on an angle of the main boom **[see page 7, line 7 – page 8, line 11]**.

3. A method of controlling a tower boom path in a boom lift vehicle, the boom lift vehicle including a telescoping tower boom pivotally coupled at one end to a vehicle base, and a main boom pivotally coupled to a tower boom nose pin at an opposite end of the tower boom **[see page 6, lines 1-12]**, the method comprising raising and lowering the tower boom between a fully retracted position and a raised position by pivoting the tower boom relative to the vehicle base and by telescoping the tower boom, the raised position including any position up to a maximum angle of the tower boom relative to the vehicle base and a maximum boom length **[see page 7, lines 7-15]**, wherein pivoting of the tower boom relative to the vehicle base and telescoping of the tower boom are performed simultaneously such that the tower boom nose pin follows a predetermined path, and wherein pivoting of the tower boom relative to the vehicle base and telescoping of the tower boom are controlled such that the nose pin predetermined path comprises (1) a constant radius equal to a fully retracted length of the tower boom for tower boom angles less than a predetermined angle relative to gravity, and (2) a substantially straight line tangent to the constant radius for tower boom angles greater than the predetermined angle relative to gravity **[see page 7, line 7 – page 8, line 11]**.

6. A method of controlling lifting functions in a boom lift vehicle, the boom lift vehicle including a telescoping tower boom pivotally coupled at one end to a vehicle base, and a main boom pivotally coupled to a tower boom nose pin at an opposite end of the tower boom **[see page 6, lines 1-12]**, the method comprising raising and lowering the tower boom between a fully retracted position and a raised position by pivoting the tower boom relative to the vehicle base and by telescoping the tower boom, the raised position including any position up to a maximum angle of the tower boom relative to the vehicle base and a maximum boom length **[see page 7, lines 7-15]**, wherein pivoting of the tower boom relative to the vehicle base and telescoping of the tower boom are performed simultaneously and independently such that the tower boom nose pin follows one of a plurality of predetermined paths depending on an angle of the main boom **[see page 7, line 7 – page 8, line 11]**.

10. A boom lift vehicle comprising:

a vehicle base **[see page 5, lines 22-26]**;

a telescoping tower boom pivotally coupled at one end to the vehicle base **[see page 6, lines 1-7]**;

a main boom pivotally coupled to a tower boom nose pin at an opposite end of the tower boom **[see page 6, lines 8-12]**; and

a control system controlling positioning of the tower boom and the main boom, the control system being configured for raising and lowering the tower boom between a fully retracted position and a raised position by pivoting the tower boom relative to the vehicle

base and by telescoping the tower boom **[see page 6, line 8 – page 7, line 6]**, the raised position including any position up to a maximum angle of the tower boom relative to the vehicle base and a maximum boom length, wherein the control system effects pivoting of the tower boom relative to the vehicle base and telescoping of the tower boom simultaneously and independently such that the tower boom nose pin follows one of a plurality of predetermined paths depending on an angle of the main boom **[see page 7, line 7 – page 8, line 11]**.

19. A boom lift vehicle comprising:

a vehicle base **[see page 5, lines 22-26]**;

a telescoping tower boom pivotally coupled at one end to the vehicle base **[see page 6, lines 1-7]**;

a main boom pivotally coupled to a tower boom nose pin at an opposite end of the tower boom **[see page 6, lines 8-12]**; and

a control system controlling positioning of the tower boom and the main boom, the control system being configured for raising and lowering the tower boom between a fully retracted position and a raised position by pivoting the tower boom relative to the vehicle base and by telescoping the tower boom **[see page 6, line 8 – page 7, line 6]**, the raised position including any position up to a maximum angle of the tower boom relative to the vehicle base and a maximum boom length,

wherein the boom lift vehicle is without an upright between the tower boom and the main boom **[see page 6, lines 15-28]**, and wherein the control system effects pivoting

of the tower boom relative to the vehicle base and telescoping of the tower boom simultaneously and independently such that the tower boom nose pin follows one of a plurality of predetermined paths depending on an angle of the main boom **[see page 7, line 7 – page 8, line 11]**.

22. A method of controlling a tower boom path in a boom lift vehicle, the boom lift vehicle including a telescoping tower boom pivotally coupled at one end to a vehicle base, and a main boom pivotally coupled to a tower boom nose pin at an opposite end of the tower boom **[see page 6, lines 1-12]**, the method comprising raising and lowering the tower boom between a fully retracted position and a raised position by pivoting the tower boom relative to the vehicle base and by telescoping the tower boom, the raised position including any position up to a maximum angle of the tower boom relative to the vehicle base and a maximum boom length **[see page 7, lines 7-15]**, wherein pivoting of the tower boom relative to the vehicle base and telescoping of the tower boom are performed simultaneously such that the tower boom nose pin follows a predetermined path **[see page 7, line 7 – page 8, line 11]**, and wherein the predetermined path is varied based on an angle of the main boom relative to gravity **[see page 6, lines 15-28, page 8, lines 22-28 and page 9, lines 6-15]**.

(VI) GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

1. Whether claims 2, 9 and 11 are unpatentable under 35 U.S.C. §112, first paragraph.

2. Whether claims 1-22 are unpatentable under 35 U.S.C. §103(a) over U.S. Published Patent Application No. 2003/0173151 to Bodtke in view of U.S. Patent No. 6,543,578 to Merz or U.S. Patent No. 5,390,104 to Fulton.

3. Whether claim 18 is unpatentable under 35 U.S.C. §103(a) over Bodtke in view of Merz or Fulton and U.S. Patent No. 5,446,980 to Rocke.

4. Whether claims 19-21 are unpatentable under 35 U.S.C. §103(a) over Bodtke in view of Merz or Fulton and U.S. Patent No. 4,113,054 to Myers.

(VII) ARGUMENT

1. Claims 2, 9 and 11 are not unpatentable under 35 U.S.C. §112, first paragraph.

The Office Action contends that the description is inadequate with regard to the "single control switch." In this context, however, the specification describes at page 6, line 29 – page 7, line 6 that a single control switch effects raising and lowering of the tower boom, and the control system 34 automatically controls tower lift and telescope functions to follow the predetermined path depending on the main boom angle. The control system 34 controls lift and telescope functions of the tower boom 18 and the main boom 24 based on outputs processed from an inclinometer 30 and a rotation sensor 32. See page 6, lines 15-28. As would be apparent to those of ordinary skill in the art, with this structure, the single control switch serves to activate control of tower lift and telescope functions via the control system 34.

In the final Office Action, the Examiner maintains that the description of the switch to enable the described movement is lacking. Appellants submit that those of ordinary skill in the art could readily comprehend the operation of a switch that serves to activate a control system programmed to carry out a particular function. With reference to the Examiner's understanding of Appellants' statements concerning the use of a single switch for "operating up and down movements," Appellants respectfully submit that the Examiner is missing the point. One novelty of the invention resides in the single switch for raising and lowering the tower boom by <u>simultaneously pivoting and telescoping the tower boom</u>. Appellants have not contended that the structure of the switch *per se* is

novel. In fact, any switch structure could be used to activate the control system. The prior art of record, however, lacks a teaching or disclosure of a single switch for activating simultaneous pivoting and telescoping.

Reversal of the rejection is thus respectfully requested.

2. Claims 1-22 are not unpatentable under 35 U.S.C. §103(a) over U.S. Published Patent Application No. 2003/0173151 to Bodtke in view of U.S. Patent No. 6,543,578 to Merz (referred to "Mertz" in the Office Action) or U.S. Patent No. 5,390,104 to Fulton.

The Office Action recognizes that the Bodtke publication lacks at least the step wherein pivoting of the tower boom relative to the vehicle base and telescoping of the tower boom are performed simultaneously and independently. In fact, Bodtke describes that an operator positions the platform 206 at a desired elevation "by controlling the angle and/or extension of one or both of the primary and secondary booms 201 and 202 relative to the chassis 204." See, e.g., page 5, lines 18 and 19. In the embodiment illustrated in Fig. 6 referenced in the Office Action, the method of controlling platform position is the same. In this context, not only does the Bodtke publication lack a teaching of the claimed simultaneous and independent pivoting and telescoping, but Bodtke also lacks any teaching of performing pivoting and telescoping such that a tower boom nose pin follows one of a plurality of predetermined paths depending on an angle of the main boom. The concept behind the varying paths that are dependent on an angle of the main boom was discussed in detail in the February 12 response.

The Office Action contends that "[b]oth Mertz and Fulton teach tower booms that are controlled independently and simultaneously to pivot and telescope the booms." The

Merz patent, however, merely describes an input device to ease the understanding of the operator with regard to movements of the machine. Merz in fact lacks any discussion of controlling the positions or coordinated movements of booms other than to facilitate activation of the desired input device. Merz thus lacks at least the subject matter wherein pivoting of a tower boom relative to the vehicle base and telescoping of the tower boom are performed simultaneously and independently such that the tower boom nose pin follows one of a plurality of predetermined paths depending on an angle of the main boom. Indeed, nowhere does the Merz patent even remotely disclose positioning and control of a tower boom that is dependent on an angle of a main boom. In fact, the Merz patent describes independent control of boom position by the operator. Such independent control is in direct contrast with the system that controls a boom position based on an angle of another boom.

In the final Office Action, for the first time, the Examiner references a specific location in Merz that purportedly supports the grounds of rejection. In this context, however, the Examiner refers to "paragraph (0017-0019)" in "Mertz," but the paragraphs in the Merz patent are not numbered, and it is not entirely clear which paragraphs are being referenced. Counting paragraphs, it seems the Examiner may be referring to column 5, lines 20-59. These paragraphs in Merz merely describe switches and motion controls to facilitate operator control. Merz does not remotely disclose positioning and control of a tower boom that is dependent on an angle of a main boom.

Fulton discloses an "adaptive control man-augmentation system" that controls the movement of a suspended work station. The device includes structure that detects movement of a directing member relative to certain axes and produces outputs related to such movement to produce movement of a work station. The example described in the specification relates to a fruit picking apparatus where a directing member is connected to the picker's body, and when horizontal movement is required, the picker leans or reaches in the desired direction of movement, resulting in matching directional movement of the platform at a rate proportional to his angle of part positioning. Independent positioning of the various platform support components directly contrasts the control system and method of the invention. That is, the Fulton patent lacks at least the claimed subject matter wherein pivoting of the tower boom relative to the vehicle base and telescoping of the tower boom are performed simultaneously and independently such that the tower boom nose pin follows one of a plurality of predetermined paths depending on an angle of the main boom.

The sections of Fulton referenced in the final Office Action (for the first time) merely relate to control signals for controlling the work station based on movements of the operator. Different operator movements will necessarily result in different boom positioning, which core premise in the Fulton patent directly contrasts important features of the claimed invention. That is, for the same main boom angle in the claimed invention, the boom nose pin will always follow the same "predetermined" path. In

Fulton, it would seem any such path would vary practically every instance (unless the operator made exactly the same movements).

Appellants thus respectfully submit that the rejection of independent claims 1, 6, 10, 19 and 22 is misplaced.

With regard to independent claim 3, the Office Action contends that it would have been obvious to modify the Bodtke publication "to enable the nose of his boom to follow a predetermined path that includes both a constant radius and a straight line." Although Bodtke references the use of an independent reference frame 241, 641 represented by a horizontal line normal to the direction of gravitational force, none of Bodtke, Merz or Fulton even remotely discloses a nose pin predetermined path defined by (1) a constant radius equal to a fully retracted length of the tower boom for tower boom angles less than a predetermined angle relative to gravity, and (2) a substantially straight line tangent to the constant radius for tower boom angles greater than the predetermined angle relative to gravity. That is, claim 3 specifically defines a nose pin path as a constant radius up to a predetermined tower angle, then a straight line tangent to the constant radius above the predetermined angle. In contrast, Bodtke describes that the operator basically has autonomous control over the position of the platform until the angle of inclination 244 reaches a predetermined angle. It is clear then that Bodtke lacks any such nose pin predetermined path including a constant radius below a predetermined boom angle relative to gravity.

Merz and Fulton do not correct this deficiency. Rather, the Merz patent relates primarily to a control device for effecting motion of an aerial work platform. Merz is not concerned with a nose pin predetermined path. As discussed previously, the Fulton patent discloses an "adaptive control man-augmentation system" that controls the movement of a suspended work station. This system is similarly unconcerned with controlling pivoting and telescoping of a tower boom such that a nose pin follows a predetermined path.

For at least these reasons, Appellants respectfully submit that the rejection of independent claim 3 is also misplaced.

With regard to the dependent claims, Appellants submit that these claims are allowable at least by virtue of their dependency on an allowable independent claim. Moreover, with regard to the single control switch defined in claims 2, 9 and 11, the Office Action contends that both Merz and Fulton disclose a single switch. As discussed previously, however, although Merz discloses the use of a single handle, the Merz device utilizes multiple switches to enable independent control. The "go button" switch 71 described in the Fulton patent is described as a "deadman" switch that presumably allows the controls to remain live while engaged. Such a switch does not cause the machine to follow a predetermined path, and even assuming somehow it could be interpreted to follow a predetermined path, this path would not vary based on an angle of the main boom.

Still further, claim 8 recites that the step of controlling an angle of the main boom relative to the tower boom comprises maintaining the boom angle relative to gravity as measured at (1) the commencement of a tower lift control, or (2) the conclusion of a main boom lift command when the main boom is active with a tower lift command. As noted, Merz lacks any reference to any boom angle relative to gravity. Additionally, Merz lacks any disclosure or remote suggestion of main boom angle control that maintains a boom angle as measured at specific instances. As noted above, although the Bodtke publication utilizes a reference line relative to gravity, none of Bodtke, Merz or Fulton teaches or suggests the step of controlling an angle of the main boom relative to the tower boom by maintaining the boom angle relative to gravity as measured at (1) the commencement of a tower lift control or (2) the conclusion of a main boom lift command when the main boom is active with a tower lift command.

Reversal of the rejection is thus respectfully requested.

3. Claim 18 is not unpatentable under 35 U.S.C. §103(a) over Bodtke in view of Merz or Fulton and U.S. Patent No. 5,446,980 to Rocke.

Initially, Appellants submit that the Rocke patent does not correct the deficiencies noted above with regard to Bodtke, Merz and Fulton. As such, Appellants submit that claim 18 is allowable at least by virtue of its dependency on an allowable independent claim. Moreover, Appellants do not contend that the use of rotary sensors to measure rotary joint movement is novel. Rather, the system including the sensing means defined in claim 18 uses a rotary sensor between the main and tower booms and a gravitationally based sensor to measure the angle of the tower. This structure allows the angle of the

main boom to be determined relative to gravity. Rocke does not include any such structure, and Appellants thus respectfully submit that the rejection is misplaced.

Reversal of the rejection is requested.

4. Claims 19-21 are not unpatentable under 35 U.S.C. §103(a) over Bodtke in view of Merz or Fulton and U.S. Patent No. 4,113,054 to Myers (referred to "Meyers" in the Office Action).

The Myers patent, however, does not correct the deficiencies noted above with regard to Bodtke, Merz and Fulton. None of the applied references provides any teaching or remote suggestion of a control system that effects pivoting of a tower boom relative to a vehicle base and telescoping of the tower boom simultaneously and independently such that the tower boom nose pin follows one of a plurality of predetermined paths depending on an angle of the main boom. Appellants thus submit that independent claim 19 and dependent claims 20 and 21 are allowable for reasons similar to those discussed above with regard to the rejection over Bodtke in view of Merz or Fulton.

Moreover, claim 21 recites that the sensing means includes an inclinometer attached to the tower boom that measures an angle of the tower boom relative to gravity, and a rotation sensor coupled between the tower boom and the main boom that determines a relative position of the tower boom and the main boom. The control system determines the main boom angle relative to gravity based on output from the inclinometer and the rotation sensor. The final Office Action addresses the subject matter of claim 21 for the first time. In this context, however, Appellants submit that merely because inclinometers and rotation sensors may be known, it would not have been obvious from

the prior art of record to use such components in the specifically claimed configuration. An obviousness conclusion on this basis is the product of improper hindsight. Indeed, none of the applied references discloses or suggests the claimed inclinometer attached to a tower boom that measures an angle of a tower boom relative to gravity, and a rotation sensor coupled between a tower boom and a main boom that determines a relative position of the tower boom and the main boom.

Even assuming the Examiner's characterizations of the applied references are accurate, the purported fact that "Bodtke teaches conventional angle sensing means relative to gravity at 661 between his tower boom 602 and main boom 601 and another conventional angle sensing means relative to gravity at 662 on his tower boom" still falls short of the invention defined in claim 21. The claimed configuration requires an inclinometer that measures an angle of the tower boom relative to gravity and a rotation sensor that determines a relative position of the tower boom and the main boom.

Reversal of the rejection is thus respectfully requested.

CONCLUSION

In conclusion it is believed that the application is in clear condition for allowance; therefore, early reversal of the Final Rejection and passage of the subject application to issue are earnestly solicited.

Respectfully submitted,

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(VIII) <u>CLAIMS APPENDIX</u>

1. A method of controlling a tower boom path in a boom lift vehicle, the boom lift vehicle including a telescoping tower boom pivotally coupled at one end to a vehicle base, and a main boom pivotally coupled to a tower boom nose pin at an opposite end of the tower boom, the method comprising raising and lowering the tower boom between a fully retracted position and a raised position by pivoting the tower boom relative to the vehicle base and by telescoping the tower boom, the raised position including any position up to a maximum angle of the tower boom relative to the vehicle base and a maximum boom length, wherein pivoting of the tower boom relative to the vehicle base and telescoping of the tower boom are performed simultaneously and independently such that the tower boom nose pin follows one of a plurality of predetermined paths depending on an angle of the main boom.

2. A method according to claim 1, wherein the raising and lowering of the tower boom is controlled with a single control switch.

3. A method of controlling a tower boom path in a boom lift vehicle, the boom lift vehicle including a telescoping tower boom pivotally coupled at one end to a vehicle base, and a main boom pivotally coupled to a tower boom nose pin at an opposite end of the tower boom, the method comprising raising and lowering the tower boom between a fully retracted position and a raised position by pivoting the tower boom relative to the vehicle base and by telescoping the tower boom, the raised position including any position up to a maximum angle of the tower boom relative to the vehicle base and a

maximum boom length, wherein pivoting of the tower boom relative to the vehicle base and telescoping of the tower boom are performed simultaneously such that the tower boom nose pin follows a predetermined path, <u>and</u> wherein pivoting of the tower boom relative to the vehicle base and telescoping of the tower boom are controlled such that the nose pin predetermined path comprises (1) a constant radius equal to a fully retracted length of the tower boom for tower boom angles less than a predetermined angle relative to gravity, and (2) a substantially straight line tangent to the constant radius for tower boom angles greater than the predetermined angle relative to gravity.

4. A method according to claim 3, wherein the predetermined angle is less than 10º relative to gravity.

5. A method according to claim 3, wherein the predetermined angle is about 6.6º.

6. A method of controlling lifting functions in a boom lift vehicle, the boom lift vehicle including a telescoping tower boom pivotally coupled at one end to a vehicle base, and a main boom pivotally coupled to a tower boom nose pin at an opposite end of the tower boom, the method comprising raising and lowering the tower boom between a fully retracted position and a raised position by pivoting the tower boom relative to the vehicle base and by telescoping the tower boom, the raised position including any position up to a maximum angle of the tower boom relative to the vehicle base and a maximum boom length, wherein pivoting of the tower boom relative to the vehicle base and telescoping of the tower boom are performed simultaneously and independently such

that the tower boom nose pin follows one of a plurality of predetermined paths depending on an angle of the main boom.

7. A method according to claim 6, further comprising controlling an angle of the main boom relative to the tower boom based on a position of the tower boom.

8. A method according to claim 7, wherein the step of controlling an angle of the main boom relative to the tower boom comprises maintaining the main boom angle relative to gravity as measured at (1) the commencement of a tower lift control or (2) the conclusion of a main boom lift command when the main boom is active with a tower lift command.

9. A method according to claim 6, wherein the raising and lowering of the tower boom is controlled with a single control switch.

10. A boom lift vehicle comprising:

a vehicle base;

a telescoping tower boom pivotally coupled at one end to the vehicle base;

a main boom pivotally coupled to a tower boom nose pin at an opposite end of the tower boom; and

a control system controlling positioning of the tower boom and the main boom, the control system being configured for raising and lowering the tower boom between a fully retracted position and a raised position by pivoting the tower boom relative to the vehicle base and by telescoping the tower boom, the raised position including any position up to a maximum angle of the tower boom relative to the vehicle base and a maximum boom

length, wherein the control system effects pivoting of the tower boom relative to the vehicle base and telescoping of the tower boom simultaneously and independently such that the tower boom nose pin follows one of a plurality of predetermined paths depending on an angle of the main boom.

11. A boom lift vehicle according to claim 10, further comprising a single control switch coupled with the control system to effect the raising and lowering of the tower boom.

12. A boom lift vehicle according to claim 10, wherein the control system is configured to control pivoting of the tower boom relative to the vehicle base and telescoping of the tower boom such that the nose pin predetermined path comprises (1) a constant radius equal to a fully retracted length of the tower boom for tower boom angles less than a predetermined angle, and (2) a substantially straight line tangent to the constant radius for tower boom angles greater than the predetermined angle.

13. A boom lift vehicle according to claim 12, wherein the predetermined angle is less than 10° relative to gravity.

14. A boom lift vehicle according to claim 12, wherein the predetermined angle is about 6.6°.

15. A boom lift vehicle according to claim 10, wherein the control system is configured to effect control of an angle of the main boom relative to the tower boom based on a position of the tower boom.

16. A boom lift vehicle according to claim 15, wherein the control system is further configured to control an angle of the main boom relative to the tower boom by maintaining the main boom angle relative to gravity as measured at (1) the commencement of a tower lift control or (2) the conclusion of a main boom lift command when the main boom is active with a tower lift command.

17. A boom lift vehicle according to claim 10, further comprising means for sensing an angle of the main boom relative to gravity.

18. A boom lift vehicle according to claim 17, wherein the sensing means comprises:

an inclinometer attached to the tower boom, the inclinometer measuring an angle of the tower boom relative to gravity; and

a rotation sensor coupled between the tower boom and the main boom, the rotation sensor determining a relative position of the tower boom and the main boom,

wherein the control system determines the main boom angle relative to gravity based on output from the inclinometer and the rotation sensor.

19. A boom lift vehicle comprising:

a vehicle base;

a telescoping tower boom pivotally coupled at one end to the vehicle base;

a main boom pivotally coupled to a tower boom nose pin at an opposite end of the tower boom; and

a control system controlling positioning of the tower boom and the main boom, the control system being configured for raising and lowering the tower boom between a fully retracted position and a raised position by pivoting the tower boom relative to the vehicle base and by telescoping the tower boom, the raised position including any position up to a maximum angle of the tower boom relative to the vehicle base and a maximum boom length,

wherein the boom lift vehicle is without an upright between the tower boom and the main boom, and wherein the control system effects pivoting of the tower boom relative to the vehicle base and telescoping of the tower boom simultaneously and independently such that the tower boom nose pin follows one of a plurality of predetermined paths depending on an angle of the main boom.

20. A boom lift vehicle according to claim 19, further comprising means for sensing an angle of the main boom relative to gravity.

21. A boom lift vehicle according to claim 20, wherein the sensing means comprises:

an inclinometer attached to the tower boom, the inclinometer measuring an angle of the tower boom relative to gravity; and

a rotation sensor coupled between the tower boom and the main boom, the rotation sensor determining a relative position of the tower boom and the main boom,

wherein the control system determines the main boom angle relative to gravity based on output from the inclinometer and the rotation sensor.

22. A method of controlling a tower boom path in a boom lift vehicle, the boom lift vehicle including a telescoping tower boom pivotally coupled at one end to a vehicle base, and a main boom pivotally coupled to a tower boom nose pin at an opposite end of the tower boom, the method comprising raising and lowering the tower boom between a fully retracted position and a raised position by pivoting the tower boom relative to the vehicle base and by telescoping the tower boom, the raised position including any position up to a maximum angle of the tower boom relative to the vehicle base and a maximum boom length, wherein pivoting of the tower boom relative to the vehicle base and telescoping of the tower boom are performed simultaneously such that the tower boom nose pin follows a predetermined path, and wherein the predetermined path is varied based on an angle of the main boom relative to gravity.

(IX) EVIDENCE APPENDIX

(NOT APPLICABLE)

(X) <u>RELATED PROCEEDINGS APPENDIX</u>

(NOT APPLICABLE)